A TEMPLATE FOR CALCULATING ROCK SURFACE ROUGHNESS

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ABSTRACT

This software (which accompanies McCarroll and Nesje, 1996, *Earth Surface Processes and Landforms* Vol. 21, 963–977) is designed to quantify the roughness of rock surfaces from profiles recorded using either a micro-roughness meter or a simple profile gauge. The roughness index used is the standard deviation of the differences between adjacent height values recorded at set horizontal intervals. Profiles are assumed to be 19 cm long with heights recorded every 5 mm. The template provided assumes that four profiles are recorded from each of ten surfaces (e.g. boulders). Roughness values are calculated using (overlapping) measurement intervals of 5 mm, 10 mm, 15 mm, 20 mm, 25 mm and 30 mm. The results are tabulated and presented as 'deviograms' which display both the magnitude and scale of roughness. The spreadsheet used was Quattro-pro for Windows, version 1.00. © 1997 John Wiley & Sons, Ltd.

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RECORDING ROUGHNESS

The simplest and most convenient instrument for recording rock surface profiles in the field is the 'profile gauge', used by carpet fitters to record the profile of obstructions. A wide variety is available but the spreadsheet template supplied here requires a profile of at least 19 cm. One end of the instrument is pressed against the rock surface and the other end is then placed on graph paper and traced (being careful to mark the top surface). McCarroll and Nesje (1996) suggest that four profiles are sufficient to characterize the roughness of small surfaces such as boulders, and that extra effort is best spent on increasing the number of surfaces. The template supplied assumes that four profiles are recorded from each of ten surfaces.

Surface profiles can also be recorded using the much more accurate micro-roughness meters, which may be manual (McCarroll, 1992) or digital (Whalley, 1994). In this case, 38 values recorded at set horizontal intervals are required to fit the template. Although the units of measurement are assumed to be millimetres, and the horizontal measurement interval is assumed to be 5 mm, these units could be altered if the scale of roughness that is of interest is very small.

ENTERING DATA

The spreadsheet supplied comprises three pages, the first of which is a template into which the data are entered. Where a micro-roughness meter has been used, the height values recorded at 5 mm horizontal intervals are entered directly. Where gauge profiles have been recorded onto graph paper, the first step is to record, at 5 mm intervals, heights (in mm) above an arbitrary datum, which can be any near-horizontal line drawn on the page. This can be done by hand, but it is much quicker to use a digitizing tablet that records x and y coordinates. The x coordinates should be the 5 mm intervals and the y coordinates represent the height values. The magnitude of the original height values is irrelevant since the roughness is calculated using the *difference* between adjacent values.

For each profile, 38 values are entered into the template, replacing the zero values supplied. It is assumed that four profiles (A to D) will be recorded from each of ten surfaces (1 to 10), such as boulders. As an example, the values for test profile 2 of McCarroll and Nesje (1996) are included as profile 1A.

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CALCULATION OF ROUGHNESS

The second page of the spreadsheet contains a template for each of the profiles entered. The data are transferred automatically from the first page and roughness values are calculated using measurement intervals of 5, 10, 15, 20, 25 and 30 mm. The templates are arranged in ten horizontal groups, with four profiles in each group. The roughness index used is the standard deviation of the differences between adjacent height values. Note that for each profile all 38 values must be entered. If shorter profiles are used the templates will have to be altered.

The data entered in the first page of the spreadsheet can also be used to calculate the 'root-mean-square roughness', which McCarroll and Nesje (1996) suggest is a convenient and reliable measure of surface roughness at the maximum scale present on a profile. This value is equivalent to the standard error of the *y*-estimate of a regression line drawn through a profile. To calculate this, use the regression option (under Tools/ Advanced math/Regression in Quattro-pro) and set the independent variable as the horizontal distance along the profile and the dependent variable as the height values along that profile. The output for profile 1A is included on the results page as an example.

PRESENTATION OF RESULTS

The results are tabulated on the third page of the spreadsheet. The roughness values obtained from all 40 profiles are presented first, followed by the mean values obtained from each of the ten surfaces. Finally, the mean values obtained from combining all 40 profiles are presented together with the sample standard deviation and two standard errors of the mean.

The results are also displayed in four graphs. That entitled '1 to 5' presents as individual histograms ('deviograms') the mean roughness values, at the six scales of measurement, obtained from each of the first five surfaces. Graph '6 to 10' displays the results from the remaining five. For ease of comparison, the graph entitled 'All ten' displays the mean values obtained from each of the ten surfaces as a composite histogram. Graph 'Site mean' displays the overall mean roughness values for the whole dataset as a single histogram. A fifth graph, entitled 'Profile', plots the first of the profiles entered (1A). To plot other profiles simply alter the dependent variable series.

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